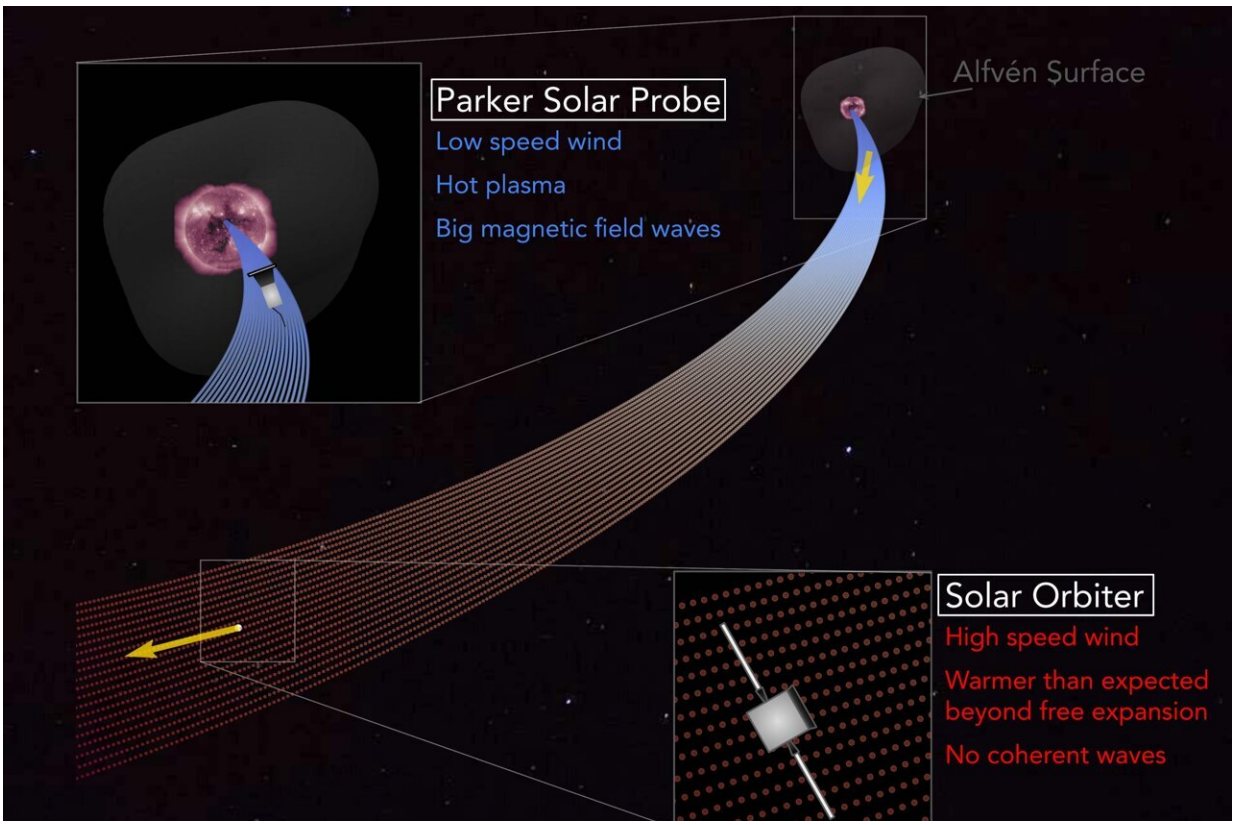
Data from space probes show that Alfvén waves drive the acceleration and heating of the solar wind

August 31 2024, by Bob Yirka



NASA's Parker Solar Probe and ESA's Solar Orbiter missions measuring the same stream of plasma flowing away from the sun at different distances. Parker measured copious magnetic waves near the edge of the corona (the "Alfvén surface"), while Solar Orbiter, located past the orbit of Venus, observed that the waves had disappeared and that their energy had been used to heat and accelerate the plasma. Credit: Yeimy Rivera and Samuel Badman. Solar image data comes

from NASA's Solar Dynamics Observatory. Imagery was created with the open source python software SunPy (https://sunpy.org/)

By studying data from NASA's Parker Solar Probe and the ESA Solar Orbiter, an international team of astrophysicists has found that Alfvén waves drive the acceleration and heating of the solar wind.

In their study, published in the journal *Science*, the group compared data from the two space probes to learn more about energy sources impacting the solar wind.

Luca Sorriso-Valvo and Francesco Malara, with the CNR–Institute for Plasma Science and Technology, in Sweden, and the University of Calabria, in Italy, respectively, have published a Perspective piece in the same journal issue outlining the work done by the group.

Prior research has shown that as the solar wind moves from the sun's corona, it cools, but also accelerates. Prior research has also shown that the cooling does not occur as quickly as it should due to free expansion—a finding that suggests an additional heat source. Some researchers have suggested the heat source likely comes from Alfvén waves—a type of electromagnetic plasma wave. In this new effort, the researchers found evidence to back up this theory.

To find out if Alfvén waves are responsible for the acceleration and heat contribution to the solar wind, the research team compared data from NASA's Parker Solar Probe and the ESA Solar Orbiter during an opportune moment of alignment in their travels.

During this period, the solar wind struck the second probe 40 hours after striking the first, giving the researchers an opportunity to measure

energy differences. They found large-amplitude Alfvén waves pushing on the solar wind, forcing a change in direction. Measurements from the second probe showed no evidence of such force. They also showed that the solar wind had grown warmer.

In calculating the amount of energy lost by the Alfvén waves, the researchers found it matched the energy required to heat the solar wind and to speed it up in a way that matched observations from the second probe.

The research team suggests their observations and calculations present a strong case for Alfvén waves as the driver behind the acceleration and heating of the solar wind.

More information: Yeimy J. Rivera et al, In situ observations of large-amplitude Alfvén waves heating and accelerating the solar wind, *Science* (2024). DOI: 10.1126/science.adk6953

Luca Sorriso-Valvo et al, Interplanetary rendezvous at a solar wind stream, *Science* (2024). DOI: 10.1126/science.adr5854

Citation: Data from space probes show that Alfvén waves drive the acceleration and heating of the solar wind (2024, August 31) retrieved 2 September 2024 from https://phys.org/news/2024-08-space-probes-alfvn-solar.html